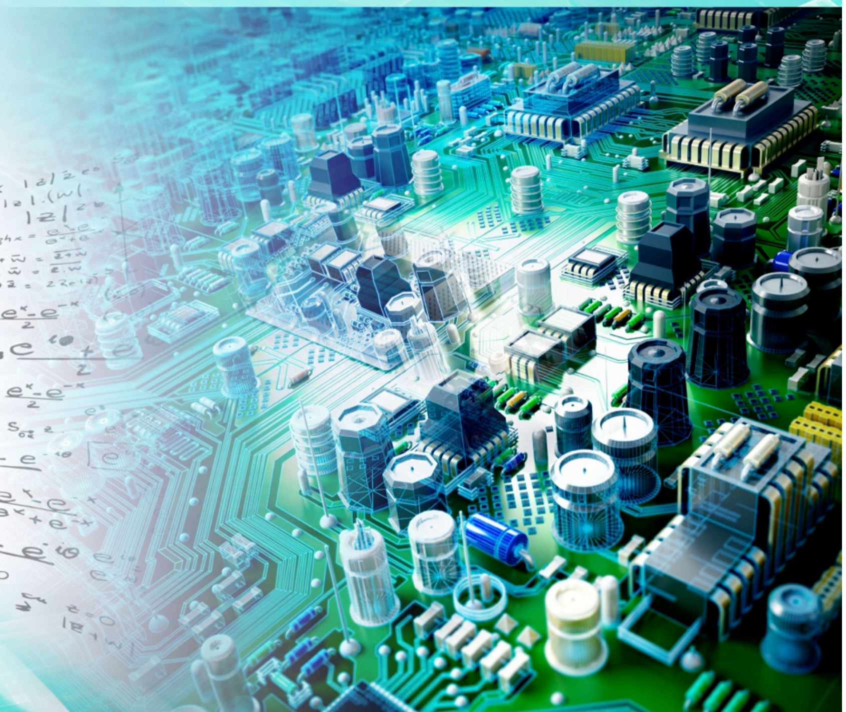
Noise 1

Exercises

TI Precision Labs – Op Amps



Texas Instruments

1. Two noise sources are in series (20mV rms, and 30mV rms). What is the total noise?

2. What is the thermal noise voltage spectral density for a 10kΩ resistor at 25C and at 125C?

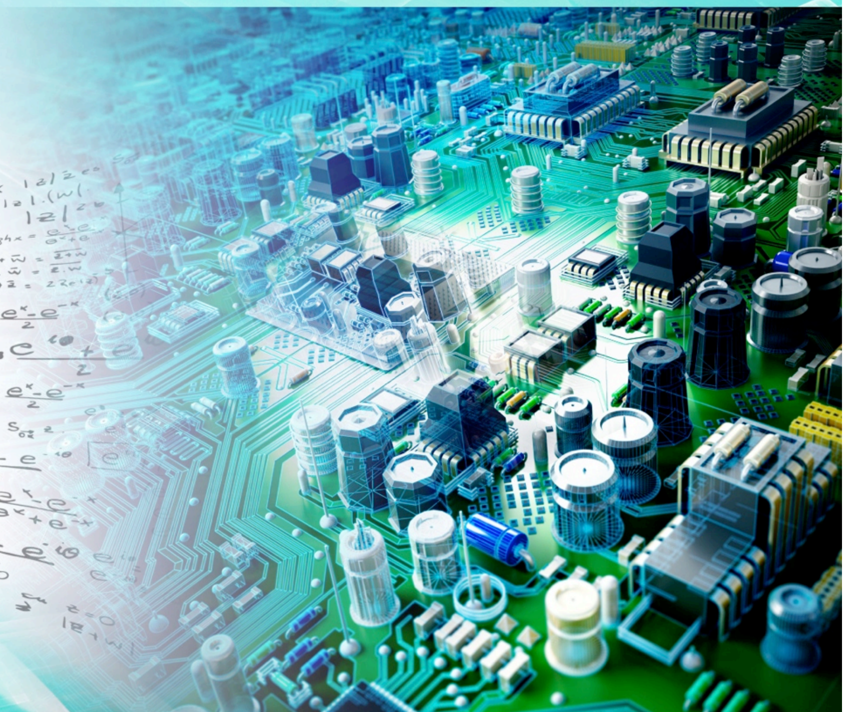
3. What resistance would be required to generate 1nV/rtHz (T = 25C)?

4. What is the rms voltage for a 10mVpp noise signal?

Noise 1

Solutions

TI Precision Labs – Op Amps



1. **Two noise sources are in series (20mV rms, and 30mV rms). What is the total noise?**

$$e_{n\_total} = \sqrt{e_{n1}^2 + e_{n2}^2} = \sqrt{(20mV)^2 + (30mV)^2} = 36mVrms$$

2. **What is the thermal noise voltage spectral density for a 10kΩ resistor at 25C and at 125C?**

$$T_n = 273 + 25 \qquad e_{n\_r} = \sqrt{4k_n \cdot T_n \cdot R_n} = \sqrt{4\left(1.38\cdot 10^{-23}\frac{J}{K}\right)\cdot(298K)\cdot(10k\Omega)} = 12.8\frac{nV}{\sqrt{Hz}}$$

$$T_n = 273 + 125 \qquad e_{n\_r} = \sqrt{4k_n \cdot T_n \cdot R_n} = \sqrt{4\left(1.38\cdot 10^{-23}\frac{J}{K}\right)\cdot(398K)\cdot(10k\Omega)} = 14.8\frac{nV}{\sqrt{Hz}}$$

3. What resistance would be required to generate 1nV/rtHz?

$$R_n = \frac{e_{n\_r}^{\;\;2}}{4 \cdot T_n \cdot k_n} = \frac{\left(1\frac{nV}{\sqrt{Hz}}\right)^2}{4 \cdot (298K) \cdot \left(1.38 \cdot 10^{-23}\frac{J}{K}\right)} = 60.8\Omega$$

4. **What is the rms voltage for a 10mVpp noise signal?** Note: peak-to-peak translation to rms is always a statistical approximation. Remember that the noise is a Gaussian signal, so there is always a finite probability that a noise measurement will be on the far tail of the curve. The calculation below assumes that +/-3 standard deviations is sufficient for a peak-to-peak approximation.

$$\frac{10mVpp}{6} = 1.667mVrms$$